

Lightweight High Performance Vests and Inserts with Dyneema® UD

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Introduction

DSM is the producer Dyneema®, the world's strongest fiber™. This fiber is 15 times stronger than steel (on same weight basis) and still floats on water. As this fiber is made of polyethylene it is very stable and does not react with most chemicals. This combination of properties makes this fiber extremely interesting for various applications. Hereby two examples which show these strong qualities:

- Dyneema® fiber is used as a suture (stitching yarn) in human bodies, for example to connect a broken tendon to a bone. This suture can stay inside the human body for many years as there is no rejection response due to the chemical inertia of polyethylene. Also the water content in the human body does not affect the yarn's strength as polyethylene does not react with water.
- Dyneema® fiber is also used in harbors to tow large vessels. Dyneema® has excellent resistance against the environmental conditions like (sea-)water, UVlight and high/low temperatures. This results in cables which can be used for a long time in a demanding environment and are so light that they can be lifted by hand.

Dyneema® in Body Armour

Since the early 1990's Dyneema® fiber is also used in bullet resistant applications, mostly using our Dyneema® UD product line. With Dyneema® UD vests are made which have the lowest weight for standards as the US Police NIJ 0101.04. Additionally Dyneema® UD is one of the few materials that can be used to produce inserts to give resistance against 7.62x39 mm AK47 MSC and 7.62x51 mm NATO ball without using a separate strike face. Those inserts are the lightest that can be found in the market resisting these threats.

These properties are recognized by many users within the military and police forces all over the world.

This is accompanied with a high quality assurance program, that amongst others include ballistic tests on every batch Dyneema® UD, visual inspection

of every linear meter produced and the capability to trace all raw materials per batch. The batch number is always printed on a roll of Dyneema® UD, see Figure 1 for an example.

Key properties of vests with Dyneema®

Some other aspects that show the excellent performance which Dyneema® UD gives in vests and inserts:

Angle impact. Many specifications only test bullets with a normal impact on the vests. With Dyneema® UD the vest wearer has even better protection against bullets under an angle which can be considered as a more realistic scenario.

Dyneema® SB21 has been tested many times for the HOSDB standard or Royal Netherlands Army, both standards have extra test requirements on angle impact. The requested impact angles are 45° and 65° between line of fire and normal to the surface of the sample. In these tests the bullet was stopped and kept in the package.

Edge impact. Tests on samples with Dyneema® SB21 have shown that it can stop 9 mm parabellum bullets that impact only 3 cm from the edge. This results in a very high area of protection.

Multiple impact. Dyneema® UD had been tested with multiple impacts many times, capable



Figure 1: Print on Dyneema® UD with type and batch number



Figure 2: A package of Dyneema® SB21 with multiple impacts from various bullets, including close to the edge and close to other impacts

to stop 9 mm impacts with a shot-to-shot distance of only 3 cm. An example is shown in Figure 2.

High temperatures. Vests with Dyneema® UD have been conditioned at temperatures up to 75°C for 8 weeks and still no difference in performance have been observed in comparison to new vests.

Further a vests has been conditioned for 6 hours at 80°C and then for 6 hours 70°C (as prescribed in the German Schutzklasse) and then passed tests according to NIJ 0101.04 level 3A.

Fire resistance. For police officers it is important that a vest still keeps its properties, also in difficult circumstances. Resistance to a short fire is one of these conditions. In a test, prescribed by a Finnish end-user, a vest is put for 30 seconds in a fire. Then immediately a 9 mm parabellum should be stopped. A vest of Dyneema® passed this test without a problem.

In addition keep note that in a real situation a person with vest burning for 30 seconds, for example due to a Molotov cocktail, would have 3rd degree burning wounds around his head.

Life time performance. A customer returned to DSM a set of vests which have been used intensively for 24 hrs per day for 3 years. Tests showed that the Dyneema® UD still the same performance against 9 mm parabellum bullets as when the Dyneema® was produced.

Vests of Dyneema® SB21 has been conditioned in the tumbler according to NIJ 0101.06 level 3A and passed these tests.

Key properties of inserts with Dyneema® UD

Dyneema® UD is an excellent choice for inserts, both for stand-alone as for used as backing behind a strike face of ceramics. The UD is pressed into a hard armour in a specific cycle, using high temperature and pressure levels.

With Dyneema® inserts can be made that can stop AK47 MSC and NATO ball and Dragunov LPS ammunition. Such inserts are the lightest inserts available on the market.

For threats with a hard steel core like armour piercing ammunition Dyneema® UD is an excellent material for backing the ceramic strike face. It results again in inserts with the lowest weight and the best performance for multiple impacts, and still stopping the lower threats like NATO Ball.

Conclusion

We think that based on the list as shown above that Dyneema® UD is an excellent material for the production of ballistic resistant vests. We hope that this overview gives you further support in selecting Dyneema® UD as basic ballistic for resistance vests and inserts.